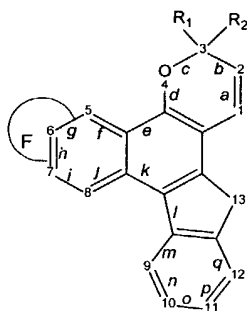


5

- 5



10

15

- 20

- 25

5. The photochromic naphthopyran of claim 1 wherein F comprises a dihydrofuran group.

6. The photochromic naphthopyran of claim 2 wherein F comprises a dihydrofuran group.

5

7. The photochromic naphthopyran of claim 3 wherein F comprises a dihydrofuran group.

8. The photochromic naphthopyran of claim 4 wherein F comprises a dihydrofuran group.

10

9. The photochromic naphthopyran of claim 1 wherein the 13-position has substituents R₃ and R₄, wherein R₃ and R₄ individually represent

a hydrogen atom,

a hydroxy group,

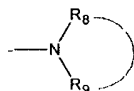
a halogen atom,

15

a linear, branched, or cyclic C1-C6 alkyl, alkenyl, or alkynyl group,

a linear, branched, or cyclic C1-C6 alkoxy or alkenoxy group,

an amino group:



20

in which R₈ and R₉, which are the same or different, independently representing a hydrogen, a linear, branched, or cyclic alkyl group comprising 1 to 6 carbon atoms, an aryl or heteroaryl group, or representing (together with the nitrogen atom to which they are bound) a 5- to 7-membered ring which can comprise at least one other heteroatom selected from oxygen, sulfur and nitrogen, said nitrogen being optionally substituted with an R₁₀ group, which is a linear or branched alkyl group comprising 1 to 6 carbon atoms, a phenyl, a benzyl, or a naphthyl,

25

an aryl or heteroaryl group selected from the group consisting of phenyl, naphthyl, phenanthryl, pyrenyl, quinolyl, isoquinolyl, benzofuranyl,

thienyl, benzothienyl, dibenzofuranyl, dibenzothienyl, carbazolyl,
indolyl,

a mono-substituted phenyl having a substituent at the para position that is
a linking group, $--(CH_2)_t--$ or $--O--(CH_2)_t--$, wherein t is the integer 1,
2, 3, 4, 5 or 6, connected to an aryl group, which is a member of another
photochromic naphthopyran,

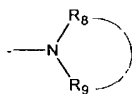
an aralkyl or heteroaralkyl group, the alkyl part of which is linear or
branched, comprising 1 to 4 carbon atoms,

a $--C(O)R_{11}$, $--OC(O)R_{11}$, or $COOR_{11}$ group, wherein R_{11} is hydrogen,
hydroxy, linear or branched C1-C6 alkyl, linear or branched C1-C6
alkoxy, phenyl, mono-substituted phenyl, naphthyl, mono-substituted
naphthyl, amino, mono(C1-C6) alkylamino or di(C1-C6)alkylamino,
e.g., N,N-dimethyl amino, N-methyl-N-propyl amino, morpholino,
piperidino or pyrrolidyl, said amino substituents being selected from the
group consisting of C1-C6 alkyl, phenyl, benzyl and naphthyl, and said
benzyl and phenyl substituents being C1-C6 alkyl or C1-C6 alkoxy,

a group $--OR_{12}$, wherein R_{12} is a C1-C6 acyl, an aralkyl or heteroaralkyl
group with a C1-C3 alkyl portion, a (C3-C7)cycloalkyl group, a (C2-
C4)alkyl group, or R_{12} is the group, $--CH(R_{13})R_{14}$, wherein R_{13} is
hydrogen or C1-C3 alkyl and R_{14} is $--CN$, $--CF_3$, or $--COOR_{15}$, wherein
 R_{15} is hydrogen or linear, branched, or cyclic alkyl, aralkyl or
heteroaralkyl,

a group $--CH(R_{16})_2$ wherein R_{16} is $--CN$ or $--COOR_{15}$,

a group $--CH(R_{15})R_{17}$, wherein R_{17} is $--COOR_{11}$, $--C(O)R_{18}$ or $--CH_2OR_{19}$,
wherein R_{18} is hydrogen, linear, branched, or cyclo-alkyl, aryl groups,
amino group of formula



R_{19} is hydrogen, $--C(O)R_{11}$, alkyl, alkoxyalkyl, phenylalkyl, mono-
alkoxy substituted phenyl-alkyl, or aryl groups,

a polyether, polyamide, polycarbonate, polycarbamate, polyurea, polyester residue, or a group ended by a polymerizable residue;
or R₃ and R₄ may together form a 3- to 7-member spiro-cyclic ring which can comprise at least one heteroatom selected from oxygen, sulfur, and nitrogen.

5

10. The photochromic naphthopyran of claim 9 wherein,

(a) in the 5- and/or 8-position, a group R₆ is present wherein R₆ represents a hydrogen,

10

a halogen, and notably fluorine, chlorine or bromine,

a linear or branched alkyl group which comprises 1 to 12 carbon atoms (advantageously 1 to 6 carbon atoms),

a cycloalkyl group comprising 3 to 12 carbon atoms,

a linear or branched alkoxy group comprising 1 to 12 carbon atoms (most advantageously 1 to 6 carbon atoms),

15

a haloalkyl, halocycloalkyl, or haloalkoxy group corresponding to the alkyl, cycloalkyl, alkoxy groups above respectively, which are substituted with at least one halogen atom, notably selected from fluorine, chlorine and bromine,

20

a linear or branched alkenyl or alkynyl group comprising 1-12 carbon atoms, preferably a vinyl or allyl group,

a linear or branched alkenoxy or alkynoxy group comprising 1-12 carbon atoms, preferably an allyloxy group,

an aryl or heteroaryl group having the same definition as that given above

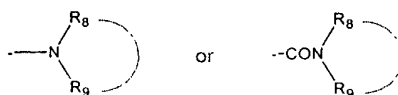
25

for aryl or heteroaryl groups within the definitions of R₃, R₄,

an aralkyl or heteroaralkyl group, the alkyl group, which is linear or

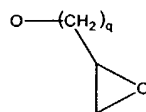
branched, comprising 1 to 4 carbon atoms, and the aryl and heteroaryl groups having the same definitions as those given above for R₃, R₄,

an amine or amide group: --NH₂, --NHR₈, --CONH₂, --CONHR₈,



R₈, and R₉ having their respective definitions given for the amine substituents of the values R₃, R₄,

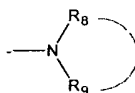
a -C(R₁₅)₂R₁₁, -OCOR₁₅, or -COOR₁₅ group, wherein R₁₁ and R₁₅ are defined supra in R₃ and R₄, a methacryloyl group or an acryloyl group, an epoxy group having the formula,



in which q = 1, 2 or 3,

a polyether, polyamide, polycarbonate, polycarbamate, polyurea or polyester residue, or a group with polymerizable residue,

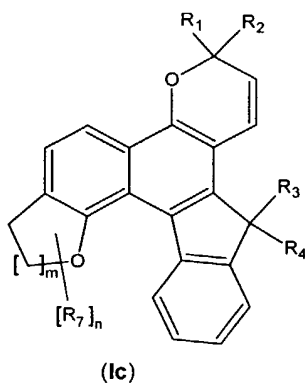
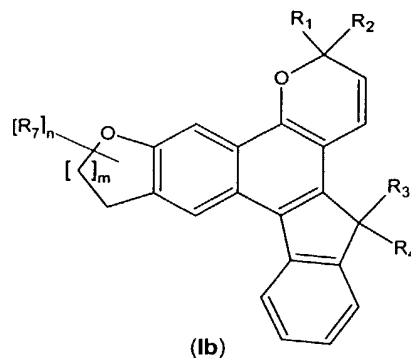
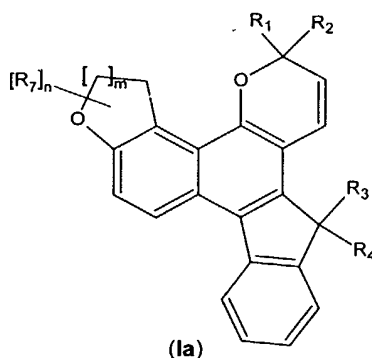
- (b) in the 9-, 10-, 11-, and 12-positions there are at most 4 R₅ groups, each being the same as R₆, defined hereinbefore; or
- (c) two adjacent R₅ together form a 5- to 7-member aromatic or non-aromatic ring which can comprise at least one heteroatom selected from oxygen, sulfur, and nitrogen, and/or at least one substituent selected from the group consisting of a C1 to C6 alkyl group which is linear, branched, or cyclic, a C1 to C6 alkoxy group which is linear or branched, and an amine group of formula -NH₂, NHR₈, or



as defined in R₃ and R₄ for amine groups, said aromatic or non-aromatic ring can be optionally annelated with a benzene group.

11. The photochromic naphthopyran of claim 10 wherein R₁ and/or R₂ represent a para-substituted phenyl group, said substituents on the para-substituted phenyl group selected from hydrogen, alkyl, alkoxy, dialkylamino, diarylamino, or R₁ and R₂ together form an adamantyl group or norbornyl group or anthracenylidene group;

12. The photochromic naphthopyran of claim 1 wherein the naphthopyran has a



formula selected from the group consisting of (Ia), (Ib), and (Ic) below, in which:
m is an integer 1 or 2,

R₁ and/or R₂, independently represent optionally substituted aryl or heteroaryl groups the basic structure of which is selected from phenyl, naphthyl, biphenyl, pyridyl, furyl, benzofuryl, dibenzofuryl, N--(C₁-C₆)alkylcarbazole, thienyl, benzothienyl, dibenzothienyl, julolidinyl groups; R₁ and/or R₂ advantageously representing a para-substituted phenyl group, said substituents are selected from hydrogen, alkyl, alkoxy, dialkylamino, diarylamino, or R₁ and R₂ together form an adamantyl group or norbornyl group or anthracenyliidene group;
R₃ and R₄ are the same or different, and may represent independently a hydrogen, a hydroxy, a halogen,

a linear, branched, or cyclic alkyl group that comprises 1 to 6 carbon atoms,

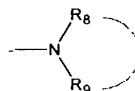
a $-OR_{20}$ group, wherein R_{20} is (C1-C3)alkyl, phenyl(C1-C3)alkyl, mono(C1-C3)alkylphenyl(C1-C3)alkyl, mono(C1-C3)alkoxyphenyl(C1-C3)alkyl, (C1-C3)alkoxy(C2-C4)alkyl, fluoro(C1-C3)alkyl, or chloro(C1-C3)alkyl,

an optionally substituted phenyl or benzyl group, said substituents being mono, di-, or tri-substituents, and selected from group R_{20} ,

a $-C(R_{21})_2X$ group, wherein X is hydroxy, alkoxy, benzyloxy, C1-C6 acyloxy, an ester group: $-COOR_{11}$, an amine or amide group: $-NH_2$, $-NHR_8$, $-N(R_8)_2$, $-CONH_2$, $-CONHR_8$, $-CON(R_8)_2$, R_{21} is hydrogen, C1-C6 alkyl, phenyl or naphthyl with C1-C6 alkyl or C1-C6 alkoxy substituents,

a polyether or polyurea residue,

or R_3 and R_4 together form a 5- to 7-member optionally substituted spiro-cyclic ring which can comprise at least one heteroatom selected from oxygen, sulfur, and nitrogen, and/or at least one substituent selected from the group consisting of a C1 to C6 alkyl group which is linear or branched, a C1 to C6 alkoxy group which is linear or branched, and an amine group of formula $-NH_2$, NHR_8 ,



the spiro-ring may be annelated with one or two benzene groups;

R_7 , which are identical or different, represent, independently

a hydrogen,

a linear or branched alkyl group which comprises 1 to 6 carbon atoms,

a cycloalkyl group comprising 3 to 7 carbon atoms,

a linear or branched alkoxy group comprising 1 to 6 carbon atoms,

a haloalkyl, halocycloalkyl, or haloalkoxy group corresponding to the alkyl, cycloalkyl, alkoxy groups above respectively, which are substituted with at least one halogen atom,

a linear or branched alkenyl or alkynyl group comprising 1-12 carbon atoms,
a linear or branched alkenoxy or alkynoxy group comprising 1-12 carbon atoms,
5 n is an integer from 0 to 2.

13. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 1.

10 14. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 2.

15 15. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 3.

16 16. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 4.

20 17. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 9.

18. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 10.

25 19. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 11.

20. A photochromic article comprising a polymeric layer containing a photochromic amount of a photochromic naphthopyran according to claim 12.

30